

Vernalis Adaptive Management Plan: Operating to Environmental Flow Targets

Presented by:
Mike Archer



California Cooperative Snow Surveys Program
November 20, 2003

What is the Vernalis Adaptive Management Plan (VAMP)?

- ◆ Part of the **San Joaquin River Agreement** (April 1999)
- ◆ SJRA is recognized in **SWRCB Water Rights Decision 1641** (adopted Dec. 1999 and revised Mar. 2000)
 - ◆ History-making commitment to implement the SWRCB 1995 Water Quality Control Plan for the lower San Joaquin River and San Francisco Bay-Delta Estuary
 - ◆ 12-year study to gather scientific information on the relative effects of flows in the lower San Joaquin River and SWP/CVP Delta export pumping on salmon smolt survival
 - ◆ Uses consensus based approach to unite large and diverse group of agricultural, urban, environmental and governmental interests

What is the Vernalis Adaptive Management Plan (VAMP)?

💧 Parties to the San Joaquin River Agreement

- 💧 California Resources Agency: DWR, DFG
- 💧 U.S. Dept. of Interior: USBR, USFWS
- 💧 San Joaquin River Group: Modesto ID, Turlock ID, Merced ID, South San Joaquin ID, Oakdale ID, SJR Exchange Contractors, Friant WUA, City and County of San Francisco
- 💧 CVP/SWP Export Interests: State Water Contractors, Kern County WA, Tulare Lake Basin WSD, Santa Clara Valley WD, San Luis and Delta-Mendota WA, Westlands WD, Metropolitan WD
- 💧 Environmental Community: National Heritage Institute, The Bay Institute of San Francisco

What is the Vernalis Adaptive Management Plan (VAMP)?

- Steady 31-day pulse flow in the San Joaquin River near Vernalis in April-May with corresponding Delta export reduction
 - Responsibility of Hydrology Group of the San Joaquin River Technical Committee
- Salmon smolt out-migration survival analysis
 - Responsibility of Biology Group of the San Joaquin River Technical Committee



San Joaquin River Basin

Map Source: DWR

VAMP Target Flow

- Incremental increase from existing flow in San Joaquin River near Vernalis

Existing Flow (cfs)	Target Flow (cfs)	Delta Export Target (cfs)
< 3,200	3,200	1,500
3,200 – 4,449	4,450	1,500
4,450 – 5,699	5,700	2,250
5,700 – 6,999	7,000	1,500 or 3,000
> 7,000	Provide stable flow to extent possible	

Where Does Incremental Increase Come From?

- Supplemental Water releases by the following San Joaquin basin water agencies:
 - Merced ID (MeID)
 - Oakdale ID (OID)
 - South San Joaquin ID (SSJID)
 - Modesto ID (MID)
 - Turlock ID (TID)
 - Exchange Contractors

Potential Modifications to Target Flow

- Double-step
- Sequential Dry-Year Relaxation
- Determined through use of a “60-20-20 Indicator”

60-20-20 Indicator

💧 A number assigned to the San Joaquin Valley Water Year Hydrologic Classification as defined in the 1995 Water Quality Control Plan and D-1641 and computed by California Cooperative Snow Surveys (CDEC report WSI)

- 💧 Wet = 5
- 💧 Above Normal = 4
- 💧 Below Normal = 3
- 💧 Dry = 2
- 💧 Critical = 1

Figure 2
San Joaquin Valley
Water Year Hydrologic Classification

Year classification shall be determined by computation of the following equation:

$$\text{INDEX} = 0.6 * X + 0.2 * Y + 0.2 * Z$$

Where: X = Current year's April – July
San Joaquin Valley unimpaired runoff

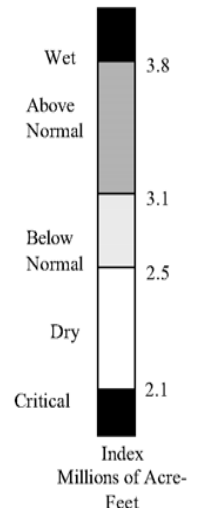
Y = Current October – March
San Joaquin Valley unimpaired runoff

Z = Previous year's index¹

The San Joaquin Valley unimpaired runoff for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year), as published in California Department of Water Resources Bulletin 120, is a forecast of the sum of the following locations: Stanislaus River, total flow to New Melones Reservoir; Tuolumne River, total inflow to Don Pedro Reservoir; Merced River, total flow to Exchequer Reservoir; San Joaquin River, total inflow to Millerton Lake. Preliminary determinations of year classification shall be made in February, March, and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

<u>Classification</u>	<u>Index</u> <u>Millions of Acre-Feet (MAF)</u>
Wet	Equal to or greater than 3.8
Above Normal	Greater than 3.1 and less than 3.8
Below Normal	Equal to or less than 3.1 and greater than 2.5
Dry	Equal to or less than 2.5 and greater than 2.1
Critical	Equal to or less than 2.1

YEAR TYPE²
All Years for All Objectives



¹ A cap of 4.5 MAF is put on the previous year's index (Z) to account for required flood control reservoir releases during wet years.

² The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.

Double-Step

- The Target Flow will equal the Target Flow that corresponds to the next higher Existing Flow.
- Occurs if the sum of the current year's forecasted and the previous year's 60-20-20 Indicators is 7 or greater. The current year's indicator is based on the 90% probability of exceedence forecast.
 - Example: If previous year was a Below Normal year (Indicator =3), then the current year would need to be a Wet (5) or Above Normal (4) year for the Double-Step to occur.

Sequential Dry Year Relaxation

- No Supplemental Water required (i.e. no VAMP flow operation).
- Occurs when the sum of the current year's and the previous two years' 60-20-20 Indicators is 4 or less.
 - Example: If previous two years were both Critical years (Indicator =1), then the current year would need to be a Dry (2) or Critical (1) year for the Dry Year Relaxation to occur.

Supplemental Water

- 💧 Limited to 110,000 acre-feet
- 💧 Allocated based on Division Agreement:

Priority in Descending Order	First 50 TAF	Next 23 TAF	Next 17 TAF	Next 20 TAF	Total
Merced ID	25	11.5	8.5	10	55
OID/SSJID	10	4.6	3.4	4	22
Exchange	5	2.3	1.7	2	11
MID/TID	10	4.6	3.4	4	22

Measurement Locations for Determining Supplemental Water Volume

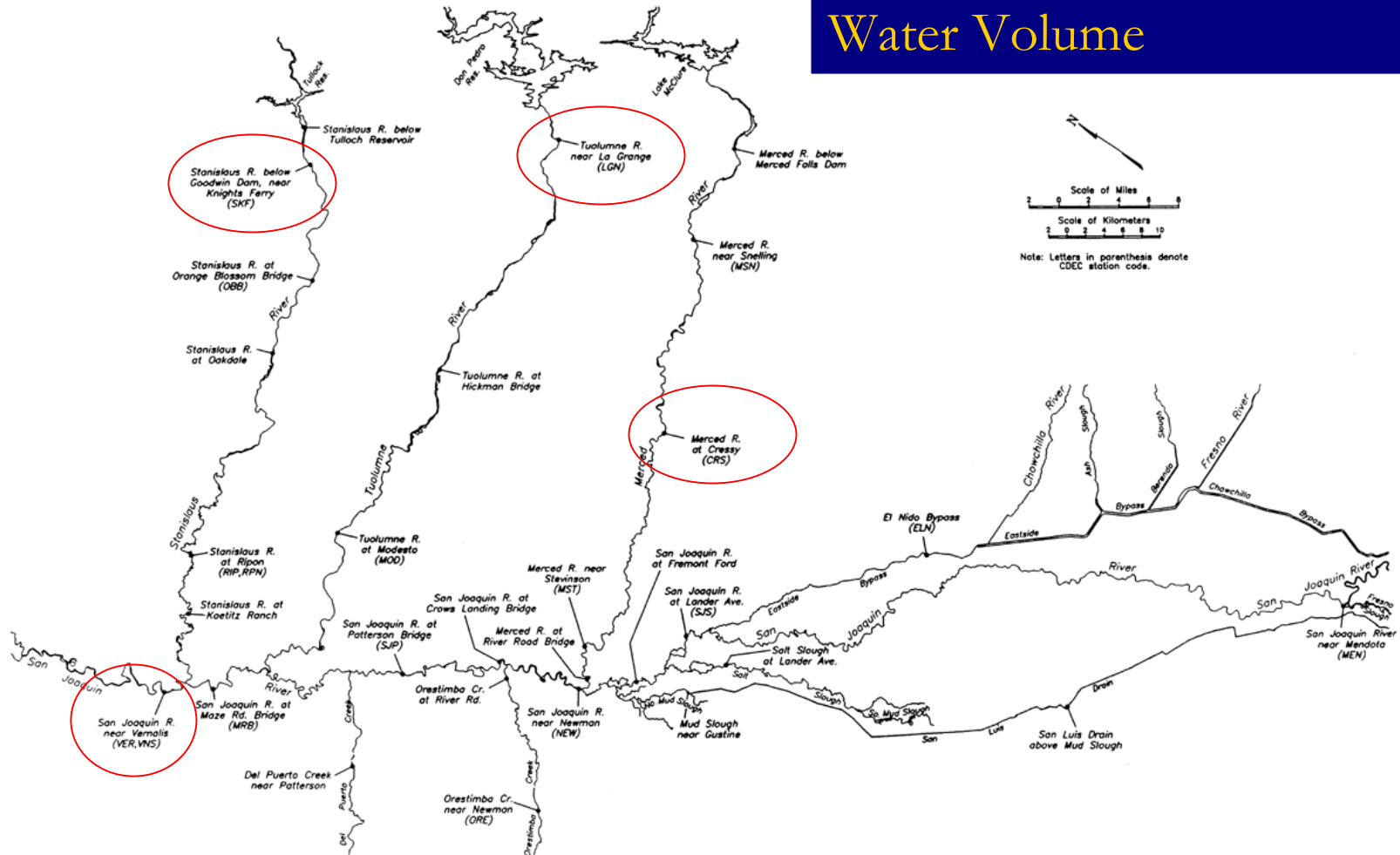


Figure 2. Lower San Joaquin River Basin Monitoring Stations.

Initial VAMP Forecast

- No later than February 10 the Hydrology Group must develop a preliminary Forecast Report of the San Joaquin River operations
- Uses 50% and 90% probability of exceedence runoff forecasts and demand conditions.
- Monthly time step
- Purpose is to determine preliminary estimate of Existing Flow during VAMP period and give the involved agencies a heads up on the potential target flows and supplemental water requirements.

Initial VAMP Forecast

💧 Example:

Probability of Exceedence	Estimated Apr 15 – May 15 Existing Flow	VAMP Target Flow	Supplemental Water Needed	Delta Export Rate
50%	5,000 cfs	5,700 cfs	43,000 ac-ft	2,250 cfs
90%	2,600 cfs	3,200 cfs	36,900 ac-ft	1,500 cfs

Daily Operation Plan

- ◆ Daily operation forecast during VAMP Target Flow period.
- ◆ Initial Daily Operation Plan developed by Hydrology Group in early March.
- ◆ Existing flows on Stanislaus and Tuolumne Rivers dependent on runoff forecasts
- ◆ Updated as conditions change.

Sample Daily Operation Plan

2003 VAMP DAILY OPERATION PLAN

MARCH 26, 2003 (A) * LOW

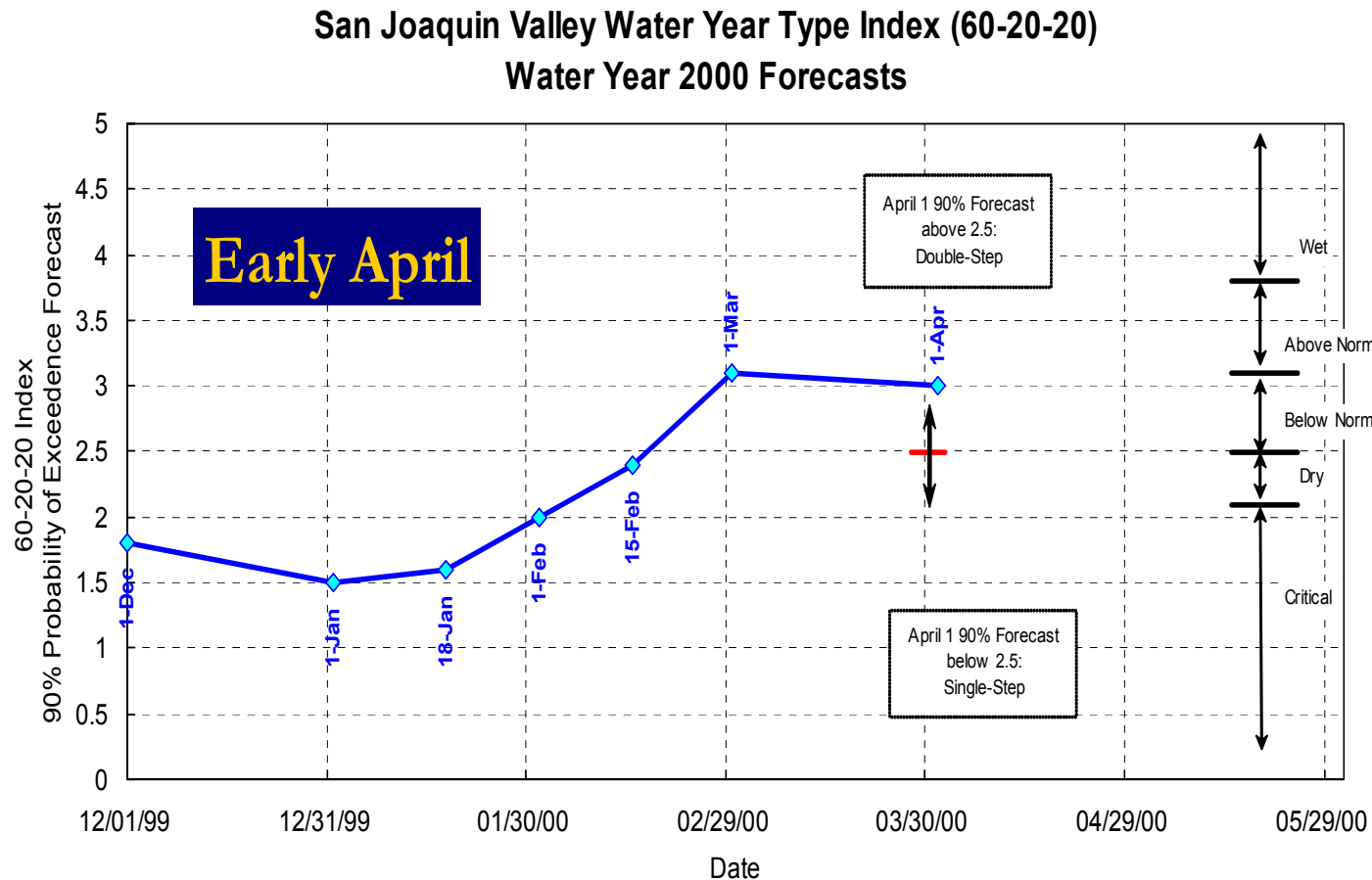
Target Flow Period: April 15 - May 15 * Flow Target: 3,200 cfs

Date	San Joaquin River near Vernalis					SJR above Merced R (2day lag) (cfs)	Ungaged Flow above Vernalis (cfs)	Merced River at Cressey				Tuolumne River at LaGrange				Stanislaus R blw Goodwin				Maintain Priority Flow Level T=Merced T=Tuol. S=Stan.
	Existing Flow (cfs)	VAMP Supplemental Flow (cfs)	Other Supplemental Flow (cfs)	Cumulative VAMP Supplemental Flow (TAF)	VAMP Flow (cfs)			Existing Flow (cfs)	MeID VAMP Supplemental Flow (cfs)	Contr VAMP Supplemental Flow (cfs)	VAMP Flow (3day lag) (cfs)	Desired FERC Pulse (cfs)	Existing Flow - Adjusted FERC Pulse (cfs)	VAMP Supplemental Flow (cfs)	VAMP Flow (2day lag) (cfs)	Existing Flow (cfs)	VAMP Supplemental Flow (cfs)	Other Supplemental Flow (cfs)	VAMP Flow (2day lag) (cfs)	
01-Apr-03						342	300	250		250	150	150		150	763			763		
02-Apr-03						339	300	250		250	150	150		150	763			763		
03-Apr-03						335	300	250		250	150	150		150	763			763		
04-Apr-03	1,802				1,802	332	300	250		250	150	150		150	763			763		
05-Apr-03	1,798				1,798	328	300	250		250	150	150		150	763			763		
06-Apr-03	1,795				1,795	325	300	250		250	150	150		150	763			763		
07-Apr-03	1,791				1,791	321	300	250		250	150	150		150	763			763		
08-Apr-03	1,788				1,788	318	300	250		250	150	150		150	763			763		
09-Apr-03	1,784				1,784	314	300	250		250	150	150		150	763			763		
10-Apr-03	1,781				1,781	311	300	250		250	150	150		150	763			763		
11-Apr-03	1,777				1,777	307	300	250	50	300	150	150		150	763			763		
12-Apr-03	1,774				1,774	304	300	250	299	81	400	400		400	763			763		
13-Apr-03	1,770	0			1,770	300	300	250	299	81	630	800	800	165	965	763	0	0	763	
14-Apr-03	2,017	50			2,067	297	300	250	299	81	630	1,100	1,100	165	1,265	763	0	0	763	
15-Apr-03	2,413	545	0	1.08	2,958	293	300	250	299	81	630	1,100	1,100	165	1,265	763	0	0	763	
16-Apr-03	2,710	545	0	2.16	3,255	290	300	250	299	81	630	1,100	1,100	165	1,265	763	0	0	763	
17-Apr-03	2,706	545	0	3.24	3,251	286	300	250	299	81	630	1,100	1,100	165	1,265	763	0	0	763	
18-Apr-03	2,703	545	0	4.32	3,248	283	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	
19-Apr-03	2,699	545	0	5.40	3,244	279	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	
20-Apr-03	2,696	545	0	6.49	3,241	276	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	
21-Apr-03	2,692	550	0	7.58	3,242	272	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	
22-Apr-03	2,689	550	0	8.67	3,239	269	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	
23-Apr-03	2,685	550	0	9.76	3,235	265	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	
24-Apr-03	2,682	550	0	10.85	3,232	262	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	M
25-Apr-03	2,678	550	0	11.94	3,228	258	300	250	304	81	635	1,100	1,100	165	1,265	763	0	0	763	M
26-Apr-03	2,675	550	0	13.03	3,225	255	300	250	304	81	635	900	900	165	1,065	763	137	0	900	M
27-Apr-03	2,671	550	0	14.12	3,221	251	300	250	429	81	760	600	600	165	765	763	537	0	1,300	M.S
28-Apr-03	2,468	687	0	15.48	3,155	248	300	250	569	81	900	429	429	165	594	763	537	0	1,300	M.S
29-Apr-03	2,164	1,087	0	17.64	3,251	244	300	250	569	81	900	300	300	160	460	763	537	0	1,300	M.S
30-Apr-03	1,990	1,212	0	20.04	3,202	241	300	250	569	81	900	300	300	160	460	763	537	0	1,300	M.S
01-May-03	1,857	1,347	0	22.72	3,204	237	300	250	569	81	900	300	300	160	460	733	567	0	1,300	S
02-May-03	1,854	1,347	0	25.39	3,201	234	300	250	569	81	900	300	300	160	460	733	567	0	1,300	S
03-May-03	1,820	1,377	0	28.12	3,197	230	300	250	569	81	900	300	300	160	460	733	567	0	1,300	S
04-May-03	1,817	1,377	0	30.85	3,194	227	300	250	869	81	1,200	300	300	160	460	733	567	0	1,300	M.S
05-May-03	1,813	1,377	0	33.58	3,190	223	300	250	869	81	1,200	300	300	160	460	733	367	0	1,100	M
06-May-03	1,810	1,377	0	36.31	3,187	220	300	250	869	81	1,200	600	600	160	760	733	127	0	860	M
07-May-03	1,806	1,477	0	39.24	3,283	216	300	250	869	81	1,200	600	600	160	760	733	0	0	733	M
08-May-03	2,103	1,237	0	41.70	3,340	213	300	250	869	81	1,200	600	600	160	760	733	0	0	733	M
09-May-03	2,099	1,110	0	43.90	3,209	209	300	250	869	81	1,200	600	600	160	760	733	0	0	733	M
10-May-03	2,096	1,110	0	46.10	3,206	206	300	250	869	81	1,200	600	600	160	760	733	0	0	733	M
11-May-03	2,092	1,110	0	48.30	3,202	202	300	250	869	81	1,200	600	600	160	760	733	0	0	733	M
12-May-03	2,089	1,110	0	50.50	3,199	199	300	250	669	81	1,000	550	550	160	710	733	0	0	733	
13-May-03	2,085	1,110	0	52.70	3,195	195	300	250	300		550	450	450	160	610	733	0	0	733	
14-May-03	2,032	1,110	0	54.91	3,142	192	300	250	50		300	389	389		389	733			733	
15-May-03	1,928	910	0	56.71	2,838	188	300	250			250	302	302		302	733			733	
16-May-03	1,863	300			2,163	185	300	250			250	215	215		215	733			733	
17-May-03	1,773	50			1,823	181	300	250			250	150	150		150	733			733	
18-May-03	1,683	0			1,683	178	300	250			250	150	150		150	733			733	
19-May-03	1,614	0			1,614	174	300	250			250	150	150		150	733			733	
20-May-03	1,611	0			1,611	171	300	250			250	150	150		150	733			733	
21-May-03	1,607	0			1,607	167	300	250			250	150	150		150	733			733	
22-May-03	1,604	0			1,604	164	300	250			250	150	150		150	733			733	
23-May-03	1,600	0			1,600	160	300	250			250	150	150		150	733			733	
24-May-03	1,597	0			1,597	157	300	250			250	150	150		150	733			733	
25-May-03	1,593	0			1,593	153	300	250			250	150	150		150	733			733	
26-May-03	1,590	0			1,590	150	300	250			250	150	150		150	733			733	
27-May-03	1,586	0			1,586	146	300	250			250	150	150		150	733			733	
28-May-03	1,583	0			1,583	143	300	250			250	150	150		150	733			733	
29-May-03	1,579	0			1,579	139	300	250			250	150	150		150	733			733	
30-May-03	1,576	0			1,576	136	300	250			250	150	150		150	733			733	
31-May-03	1,572	0			1,572	132	300	250			250	150	150		150	733			733	

								VAMP Period											
Avg. (cfs):	2,278	922	3,200	248	300	250	516	81	847	730	730	163	893	750	163	0	913		
Supplemental Water (TAF):	56.71						31.72	4.98				10.00			10.01				

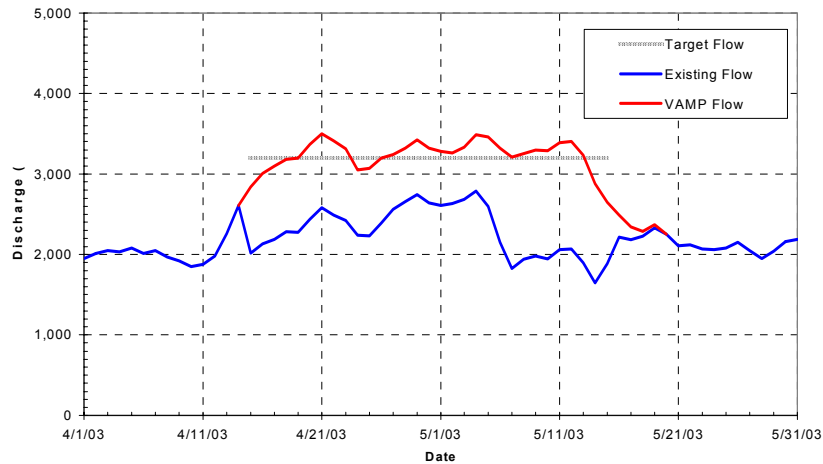
To Double-Step or not to Double-Step?

💧 Example: 2000 (much more interesting than 2003)

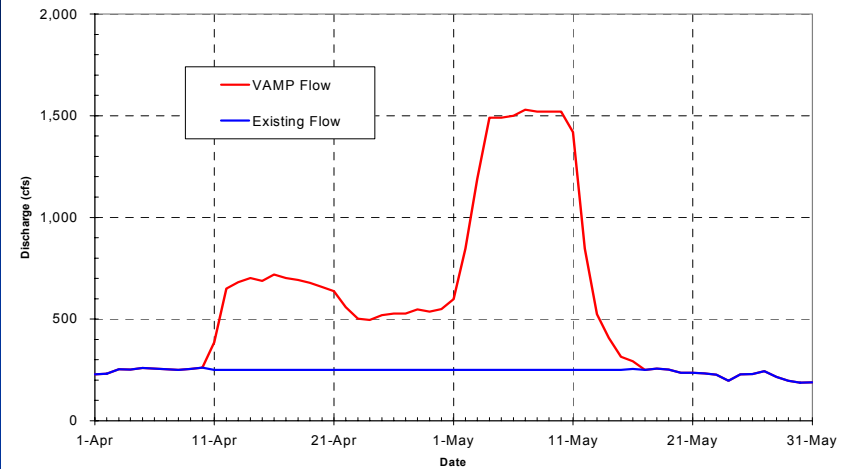


2003 VAMP Flows

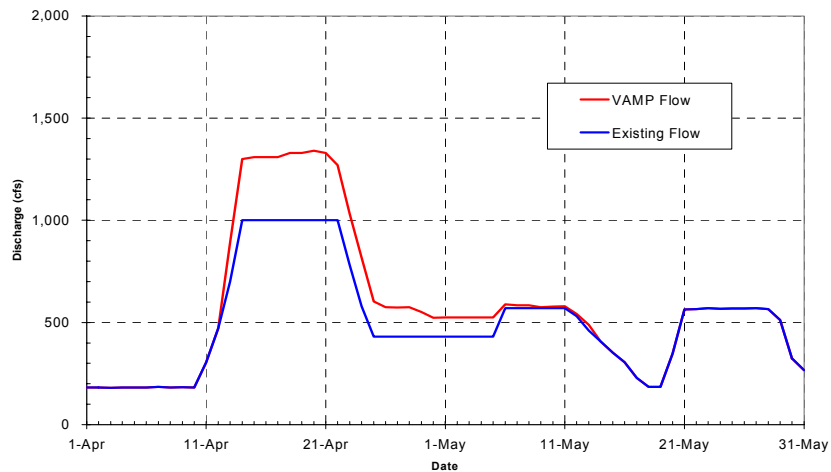
**2003 VAMP
San Joaquin River near Vernalis**



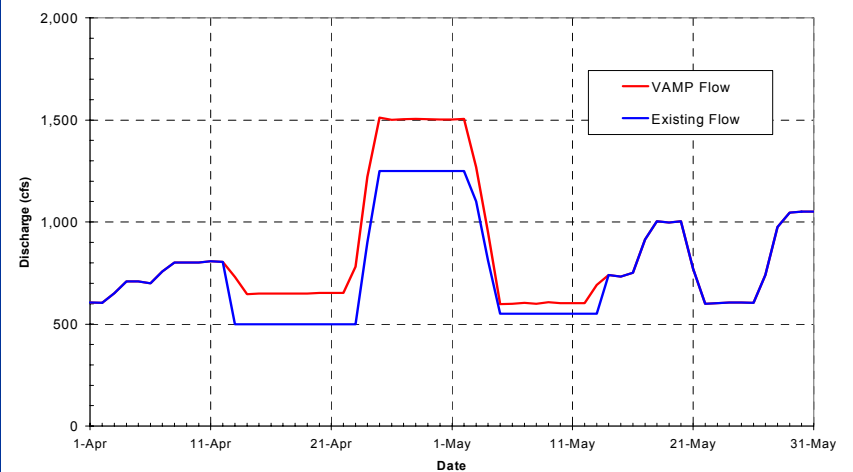
**2003 VAMP River Flows
Merced River at Cressey**



**2003 VAMP River Flows
Tuolumne River below LaGrange Dam**

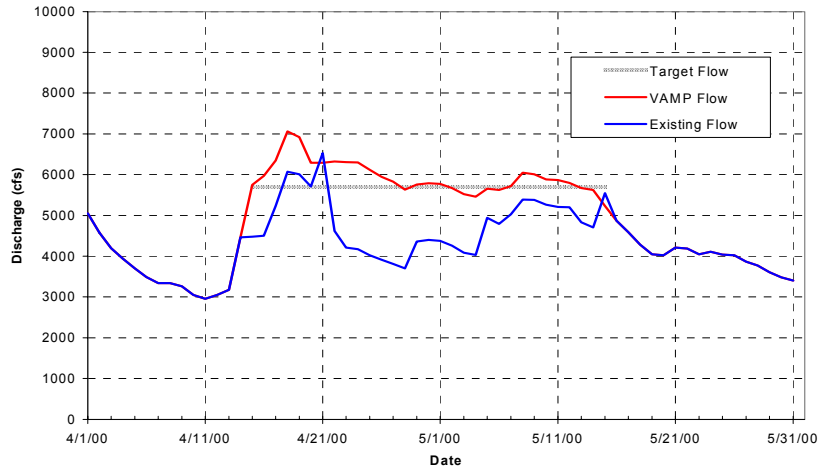


**2003 VAMP River Flows
Stanislaus River below Goodwin Dam**

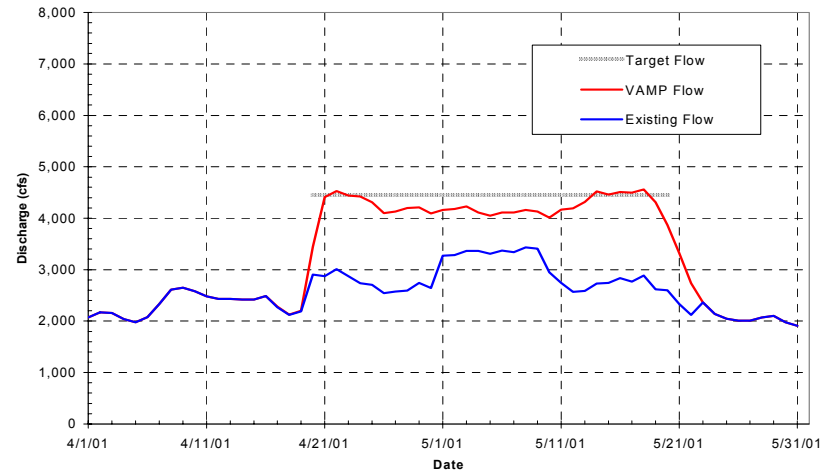


VAMP Pulse Flows, 2000-2003

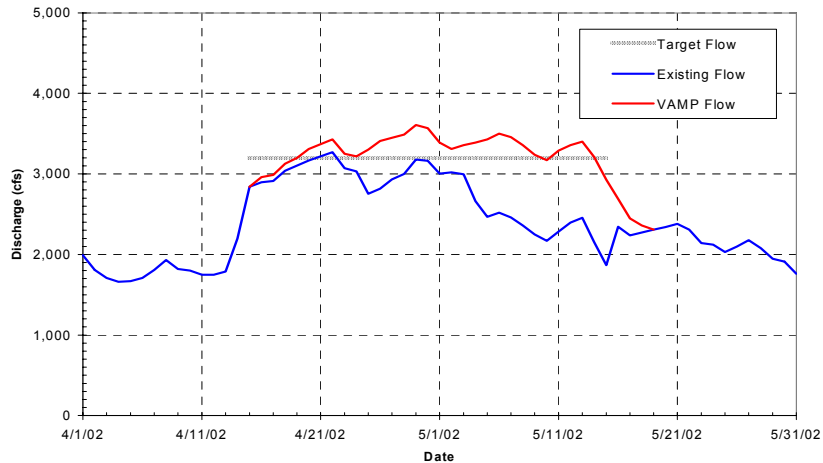
2000 VAMP
San Joaquin River near Vernalis



2001 VAMP
San Joaquin River near Vernalis



2002 VAMP
San Joaquin River near Vernalis



2003 VAMP
San Joaquin River near Vernalis

